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MAN-MADE LAKES AND BIRDSTRIKE RISK: CHANGES IN WINTERING BIRD COMMUNITIES DURING THE LAKES' AGEING

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ABSTRACT

In the Donaumoos near Ingolstadt, Bavaria, gavel-pit lakes in the vicinity of two air-bases were investigated with respect to the species succession of wintering waterfowl with increasing age of biological and morphological parameters of the lakes. The first species visiting young lakes were herbivorous ones searching for food in the littoral zone. They were followed by omnivorous diving macrophytes. Next in line were birds diving for ground-dwelling animals. Though even on lakes smaller than 4 ha great numbers of birds could be seen in some cases, as a rule lakes had to be larger than 5 ha to be attractive for waterfowl. Apart from the size of a lake, bird numbers were influenced by its structure and the amount of food. The most effective way of making large gravel-pit lakes less attractive for waterfowl and thus reduce the birdstrike risk, is their subdivision by dikes.

(Keywords: man-made lakes, waterfowl, species succession)

Man-made Lakes and Birdstrike Risk:
Changes in Wintering Bird Communities During the Lakes' Ageing

1 Introduction

There are two military air-bases situated in the Donaumoos, a flat terrain with high groundwater level in Germany's pre-alpine region south of the River Danube close to Ingolstadt (fig. 1). The fluviatile sediments found there consist of high-quality gravel, which makes the area interesting for mining companies. Up to the sixties of this century, the size of the gravel-pits ranked between a few hundred squaremetres and about 25 acres. Since 1970, due to new techniques and changes in the legislative background, the size of the pits rose rapidly. At the moment, the largest area being under excavation covers almost 1000 acres, but there no uniform waterbody is being created, because aspects of flight-safety led to the demand of having the lake subdivided by dikes (fig. 2).
The effects of the creation of more and more and larger and larger lakes on waterfowl have been investigated since 1981 because with increasing numbers of birds, the risk of birdstrikes increases, too.

2 Results

2.1 Breeding birds

During the first phase of the lakes' development the still unvegetated sandy or gravelly banks of the pits are ideal breeding-places for Little Ringed Plovers (Charadrius dubius) Yet this species is found there in a few specimens only, probably due to frequent disturbance by people during the breeding season. Sand-Martin (Riparia riparia) and Kingfisher (Alcedo atthis), in contrast to most other gravel pits, do not breed in that region at all. The reason is that because of the high groundwater level (between 0.8 and 1.5 metres below surface) the banks are not high and steep enough.
Unless accelerated by man, the first spontaneous vegetation (reeds and bushes) arises on the banks and in the shallow parts of the lakes between four and eight years after the end of the excavation resp. in larger pits after the creation of the first bank. Protected by the vegetation during this period other bird species start colonizing the pits; in the investigated area the Reed Warbler (Acrocephalus scirpaceus) is the characteristic passerine species with several breeding pairs at every larger pit.
The first breeding-birds among waterfowl are Crested Grebe (Podiceps cristatus), Mallard (Anas platyrhynchos), Coot (Fulica atra) and - much less frequent - Moorhen (Gallinula chloropus) and Little Grebe (Tachybaptus ruficollis). Recently, even the Grey-lag Goose (Anser anser) became an inhabitant of the Donaumoos - with constantly increasing numbers. This population according to SCHMAGER (1986) originated from a few geese released by hunters.
Despite the biotop-structures being favourable at least in parts, no further species of waterfowl were registered breeding in any of the pits up to now.

2.2 Migrants/ wintering birds

Of much greater importance than breeding birds are with respect to potential hazards for the air traffic the migrating and wintering birds. That is because the risk of severe collisions between birds and aircraft increases with the number of birds, their flight activity, and their weight. For this reason, special attention was paid to the development of the numbers of wintering birds on the lakes. By the fact that the lakes meanwhile reached a magnitude that from a bird's- eye view the mere optical impression makes them very attractive already, the Donaumoos became an important area for wintering waterfowl.

2.2.1 Species succession

As an example the changes of the bird-population on the lakes in the Feilenmoos, the part closest to the Manching air base, are presented in the following. Since changes take place slowly and step by step, on the figures for a better understanding only the states in 1981 and those five and ten years later are presented. In order to register the maximum numbers of wintering birds - because the cause greatest risk to flight-safety - the investigations were made at the end of November or the beginning of December, just before the lakes froze over.

The largest one of the lakes (in the south-western part of the area) was created between 1970 and 1984 with minor changes till 1989. The size is about 50 ha (130 acres), the maximum depth 6.5 meters, but even in the centre of the lake, there are shallow parts and islands.

In 1981, only Mallards were found (see fig. 3), a bird species searching for food (mainly plants, to a minor extent small animals, too,) on the banks or in shallow water up to a depth of 48 cm. The lacking of diving birds was due to the turbidity of the water caused by inorganic particles, because this prevented a colonisation of the benthic regions by submerged plants, so there was no adequate food supply.

Five years later (fig. 4) Mallards were still the most frequent species, yet the number of species was much larger already. The Pochard (Aythya ferina) was the first diving duck found there; its food consists of benthic macrophytes and animals. Two of the three fish-eating birds (Crested Grebe, Cormorant) chased their prey by diving, they profit from the increasing transparency of the water. Grey-lag Geese, though taking up their food on the surrounding agricultural land, use the lake as a roosting place because of its favourable structure (islands and great distance of the centre from all lakesides).

Till 1991 (fig. 5) the number of species and individuals of diving birds had increased further because of the immense increase in benthic organisms that always results from accelerated eutrophication of lakes. By this time, the zebra-mussel had been imported into the lake. This mollusk is the main food-source for the Tufted Duck (Aythya fuligula) and therefore the reason for the occurrence of this bird species.

The north-eastern parts of the area had been excavated mainly between 1970 and 1980. Yet in some gravel-pits the works are still going on, besides new excavations partial refilling of lakes or their subdivision by dikes takes place. Till the end of the eighties, the water was turbid in most of the lakes. This hampered or

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even completely prevented the development of submerged macrophytes. Because of this, during that time few birds only visited these lakes, the Mallard being the dominant species (see fig. 3 and 4). During the further development of the lakes, the transparency of the water increased and meanwhile the bottom of the older lakes is completely covered with macrophytes up to a depth of about 4.5 metres. In that vegetation, great numbers of aquatic insect-larvae and mollusks are found, with the consequence of an increasing attractiveness of the lakes for diving birds (Coots, Pochards; see fig. 5, in 1993 even Tufted Ducks).
The main reason for that unusually fast ongoing eutrophication and by that the development of a food-chain with aquatic birds at the end, is the use of the lakes as fishing-grounds with the release of an inadequate amount of fish. To have the fishes grow, the fishermen either feed them or fertilise the water, both resulting in an increase of the trophic state of the water.

2.2.2 Bird numbers

Besides the lakes mentioned above, several other ones were investigated in the Donaumoos (37 altogether). On this basis, an attempt was made to correlate numbers of wintering birds with the size of the lakes, in a similar way as REICHHOLF (1990) did for man-made lakes in the Erdinger Moos and the region west of Munich.
Fig. 6 shows the dependence between the maximum bird number (n) and the lakes' surface (F). The correlation can be described by the formula $n = 10.16F - 29$. That means up to a size of about 3 ha, there is little chance only that birds consider a lake to be interesting enough to search for food or rest on it.
Because of the partly wide dispersion of bird numbers there arises the question about the reasons for extreme discrepancies between the numbers found in reality and the expected values according to the regression.
REICHHOLF (1990) interpreted his results in that way, that merely the trophic state and the size of a lake but not the structure are responsible for its attractiveness for birds. In contrast to that, the results of the investigations in the Donaumoos reveal that even the structure is a decisive factor influencing bird numbers.
If the numbers are by far higher than on "average" lakes (see. no. 1 to 5 on fig. 6) this, as a rule, is the result of an extraordinary good food-supply. Lake no. 2 served as a receiving water for the sewage treatment plant of a small village for decades. Therefore the bottom is densely populated by chironomids and Tubifex. In lake no. 4, the bottom is completely covered with Ceratophyllum with up to 1700 water-snails living there per m^2. Because of the low depth (4.2-4.5 metres) this enormously rich food source can easily be reached by diving birds. Lake no. 5 is situated right on the outskirts of a larger town and therefore despite of its size it has the character of a pond in a park with the birds being fed there by people. Prevailing species on that lake were those accustomed to the presence of man: Mallard, Coot and Mute Swan.
Yet in some cases the reasons for high bird densities remain unknown (lake no. 1 and 3) if among a homogeneous group of lakes some are visited by flocks of birds while on the others there are no birds at all.
Below average are bird numbers, apart from pits still under excavation and therefore with intensive disturbances, if either the water is made turbid by inorganic matter (lake no. 6) or if the shape of

the lake is unfavourable, as it is the case with lake no. 7 in an extreme way. The latter lake is long and narrow, so the distance of no part of the surface is greater than 100 m from the closest bank. This obviously is adverse to the birds' need for safety and so they avoid landing there. (That is why lakes smaller than about 4 ha (10 acres) are not very attractive for birds.) On larger lakes I observed, that, if people approached a bank, ducks and other waterfowl swam to a distance of about 150 m from that place. Since they would be too close to another bank with potential hazards if the did so on a narrow lake, they avoid such lakes whenever possible.

3. Discussion

The investigations about the succession of waterfowl on man-made lakes reveal, that single birds visit the lakes already a short time after their completion, larger lakes even while they are under construction. Yet not earlier than about five years after the end of an excavation the colonization of the lake by submerged vegetation is that dense that it - together with the inhabiting lower animals - can be the food source for a bird population rich in species and individuals.
The first species visiting a lake in search for food are dabbling ducks (food-uptake in the littoral zone). They are followed by diving species with a decreasing percentage of phytogenic food. The last species appearing are those that feed exclusively on benthic animals, which in turn are the organisms that do not colonize the lake's bottom in sufficient numbers unless the lake has reached at least a mesotropic state.
First appearance and numbers of fish-eating bird species however are no indicators for a certain stage of succession in a lake since development, species composition, and density of fish in almost all cases is the result of artificial measures.

As soon as the size of lakes exceeds the "threshold value" of about 4 ha (10 acres), the number of birds increases quite steadily with increasing lake-size. But apart from the size, the structure an the trophic state influence bird numbers, to a certain extent the latter is the most important factor, because the available amount of food depends on it.
Structural parameters that influence bird numbers and thus cause deviations from the expected value for mesotrophic lakes given by the regression, are

- water depth. It has a positive effect, if it is that low, that the benthic region lies within the euphotic zone completely or at least to a major part. In this case macrophytes can grow there and the bottom can easily be reached by diving waterfowl.
- the shape. It has a negative influcence, if the distance between the centre of a lake and its banks is shorter than the flight distance of the birds, that means if the lakes are narrow. (This fact is used to reduce bird numbers and thus the birdstrike-risk, if it is not possible to prevent excavations in the vicinity of airfields. In this case larger excavation areas are subdivided by dikes to create several less attraktive small lakes instead of a large one - see fig.2.)
  On the other hand lakes that have a too low trophic state or are too deep to serve as feeding grounds, can be attractive roosting places if the surface is large enough to satisfy the birds' need

for safety. (In this case periodical flights take place between such a lake and the feeding grounds.)

4. Literature

REICHHOLF, J. (1990): Untersuchungen über die Besiedlung von künstlichen Gewässern (Kies- und Sandabgrabungen) durch Wasservögel. Vogel u. Luftverkehr 10 (2), 86-97

SCHMAGER, P. (1986): Die Vögel des Donaumooses. Anz. orn. Ges. Bayern 25, 207-216.

FIGURE 1. The Donaumoos near Ingolstadt/Bavaria with Manching- and Neuburg-Airbase

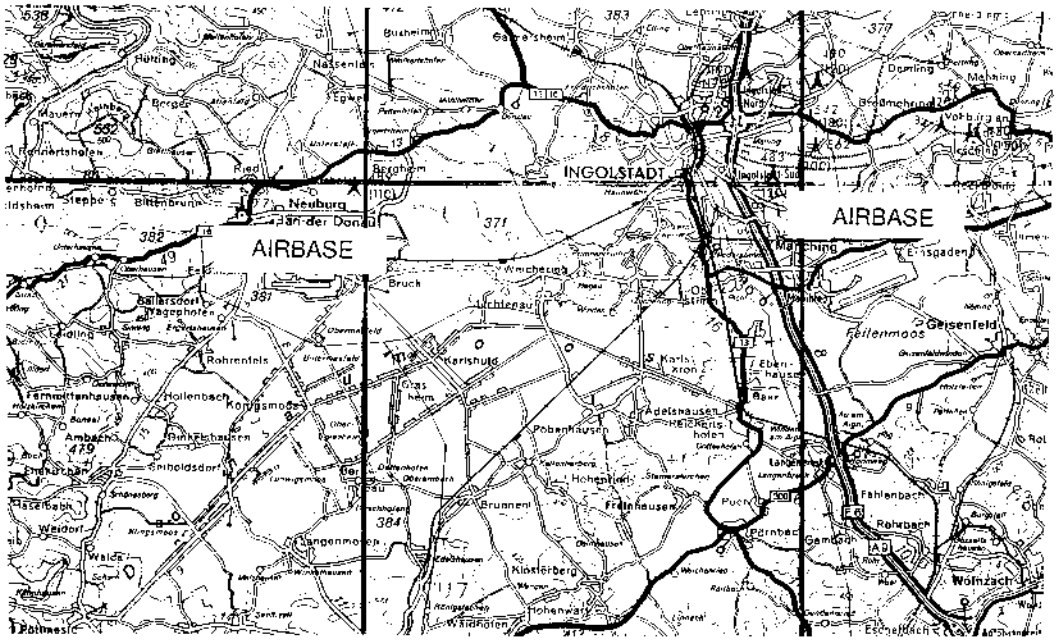


FIGURE 2. Concept for Subdivision of Gravel-pit Lakes to Reduce Attractiveness for Waterfowl

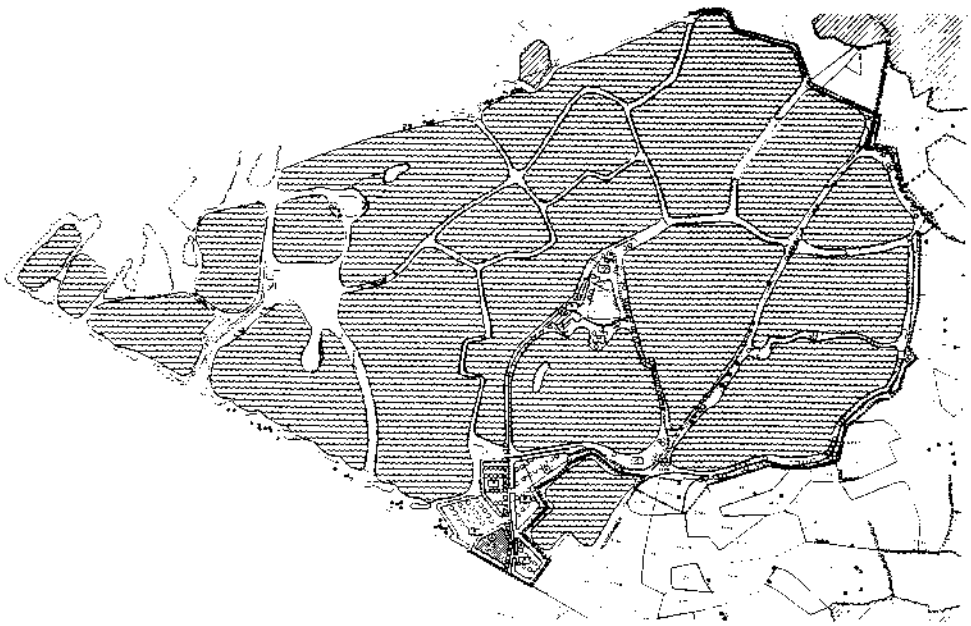


FIGURE 3. Wintering Waterfowl on Gravel-pit Lakes near Manching-Airbase in 1981

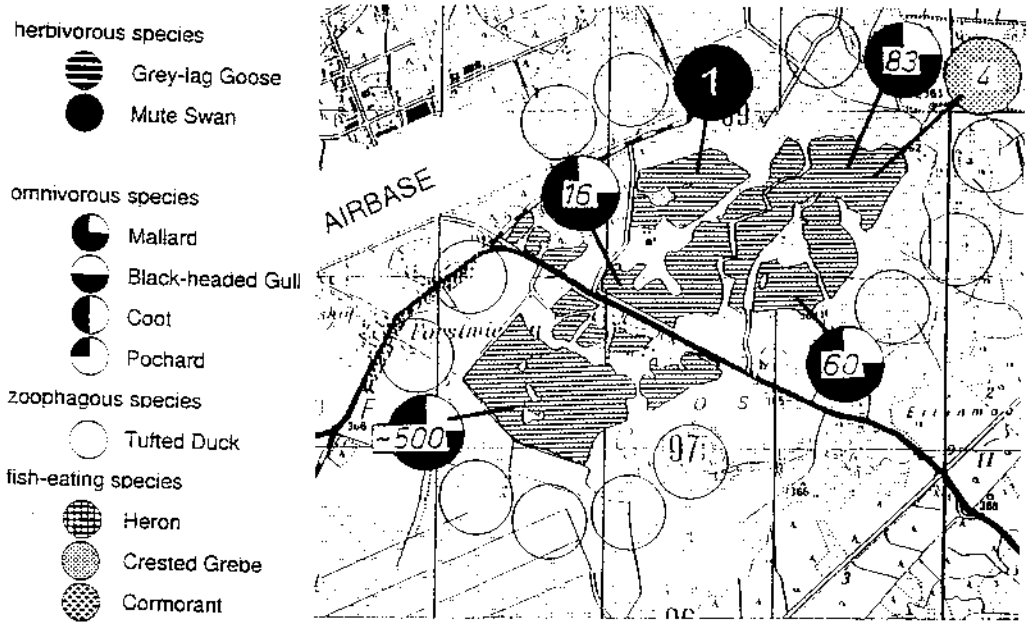


FIGURE 4. Wintering Waterfowl on Gravel-pit Lakes near Manching-Airbase in 1986

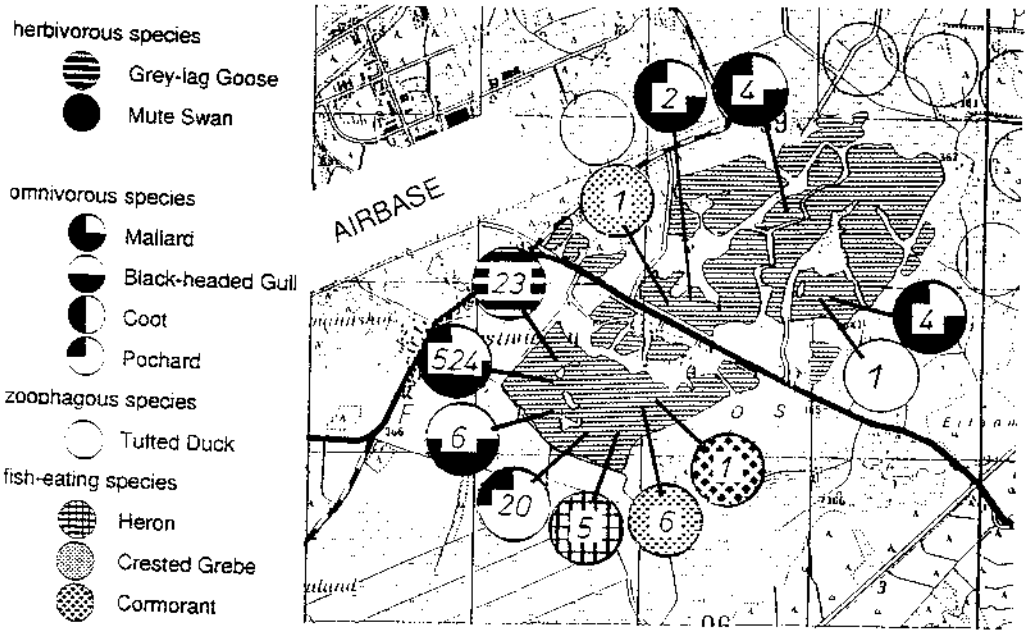


FIGURE 5. Wintering Waterfowl on Gravel-pit Lakes near Manching-Airbase in 1991

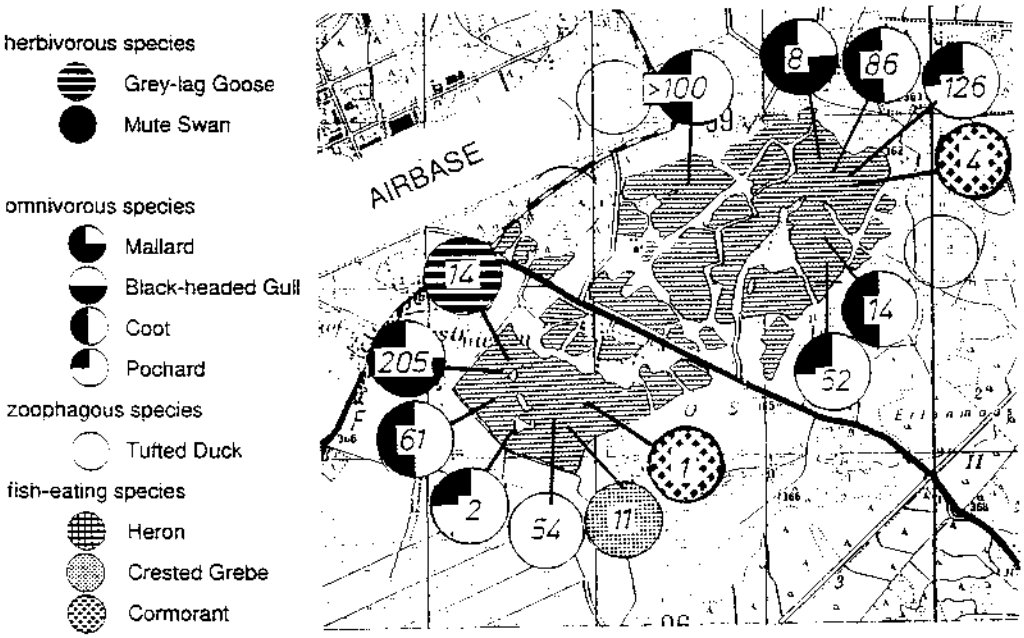
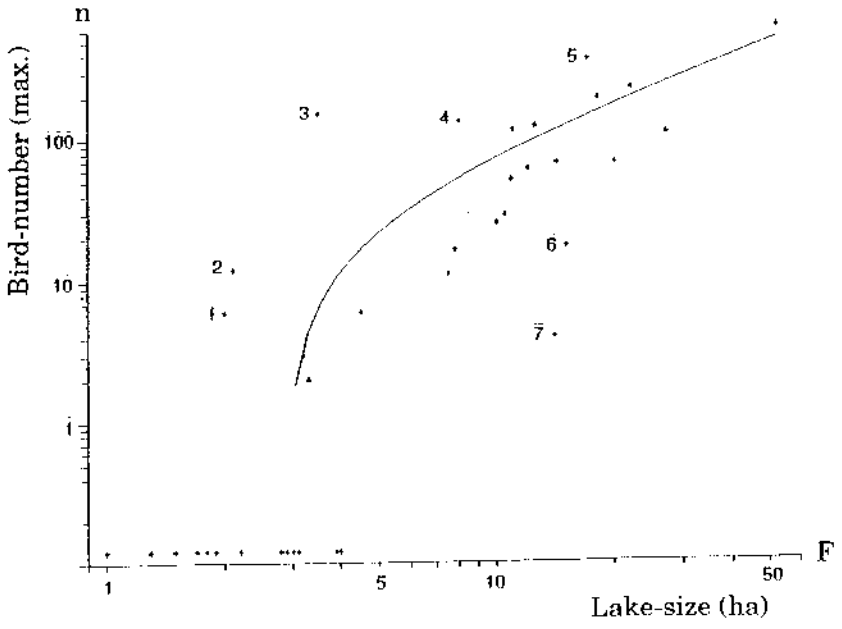


FIGURE 6. Correlation Between the Size of Man-made Lakes (F) and Maximum Numbers of Waterfowl (n). For Further Explanations See Text.



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